

2009 U.S. Army Corrosion Summit

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Clearwater Beach, Florida

**SENSOR ENABLED WATER QUALITY AND
CORROSION DEGRADATION ASSESSMENT
SYSTEMS FOR WATER DISTRIBUTION
NETWORKS**

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OSD Corrosion Control Program

- **Congressional Directive to DoD**
 - **Public Law 107-314, December 2002 Sec: 1067:**
Prevention and mitigation of corrosion of military equipment and infrastructure
- **Tri-Service in nature**
- **Army facilities projects are co-funded with ACSIM-IMA**
- **We greatly appreciate their sponsorship, visibility, and support**



Components of Water System Quality and Corrosion Monitoring and Analysis

Detection with Wireless Sensors

- **Corrosion Rate Sensors**
- **HACH Pipe-Sonde Water Quality Sensors**
- **HACH Guardian Blue Water Distribution Monitoring Process Sensor**

Dynamic Modeling

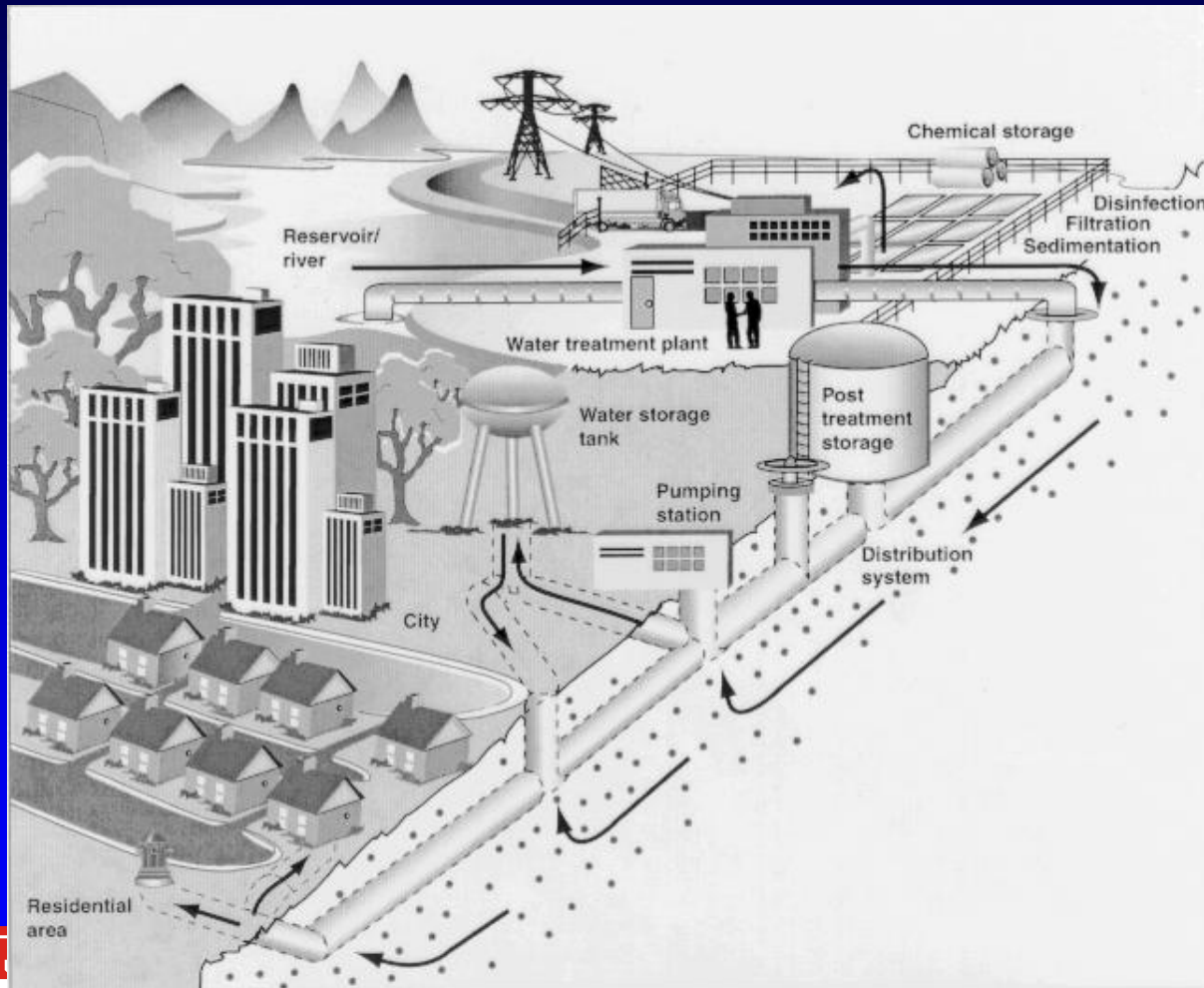
- **Hydraulic Modeling**
- **Chemical Fate and Transport**

Integration of Sensors and Models in Support of Water Distribution Networks

- **System Assessment**
- **Trend Analysis**
- **Specifically designed for use by operations**
 - **Simple to use- engineering schematic like interface**
 - **Multiple views- Schematic and Physical (GIS-like)**



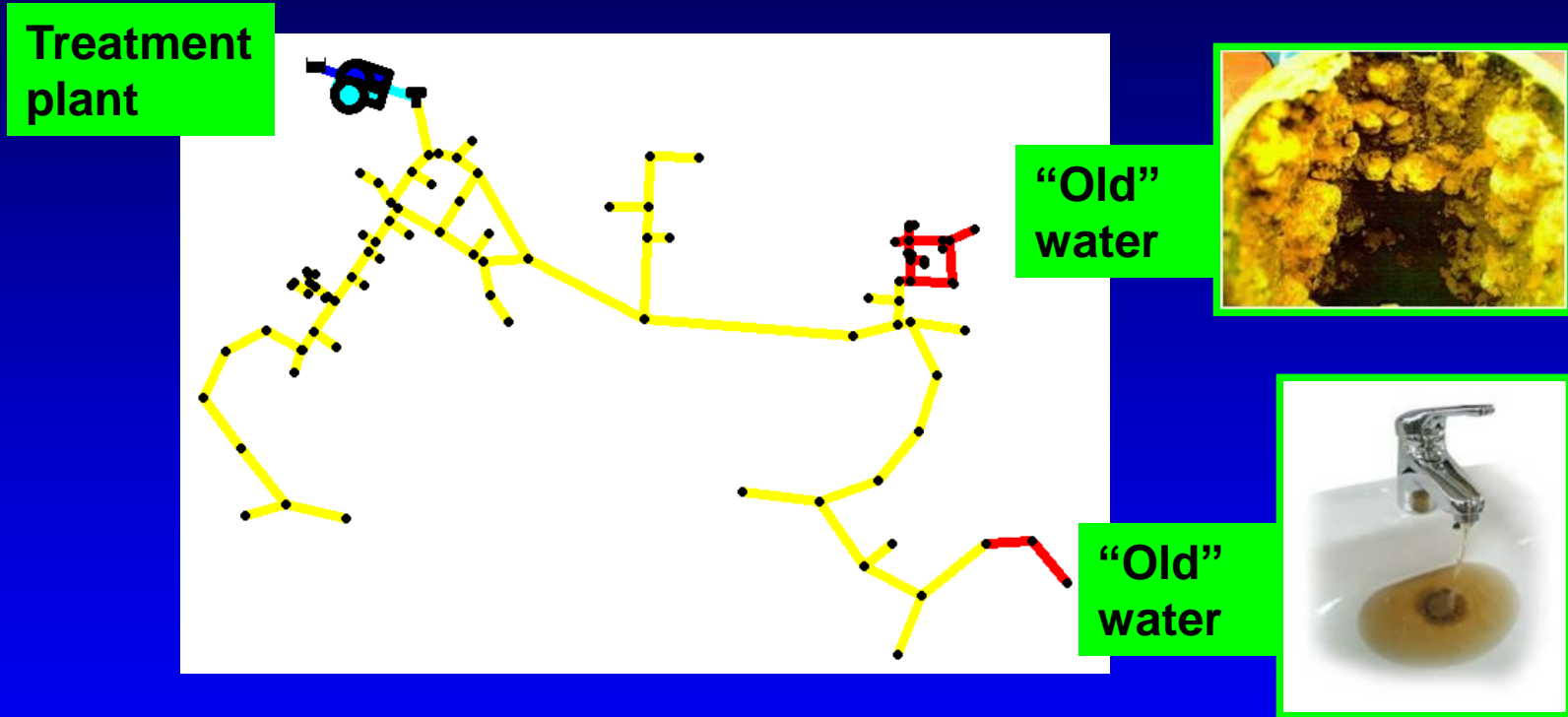
Typical Water Distribution Systems



- **Potential corrosion problems**
- **Threat to Water Potability**
- **Threat to Fire Suppression**
- **Lack of system redundancy**
- **Large area subtended by the system**
- **Treatment chemicals**
- **Control systems (SCADA)**



Degradation of water quality in the distribution system can result in undetected localized corrosion problems



- Corrosion inhibitors and disinfectants are consumed
- Residence time controlled by system hydraulics
- Remote and low-use areas are especially problematic

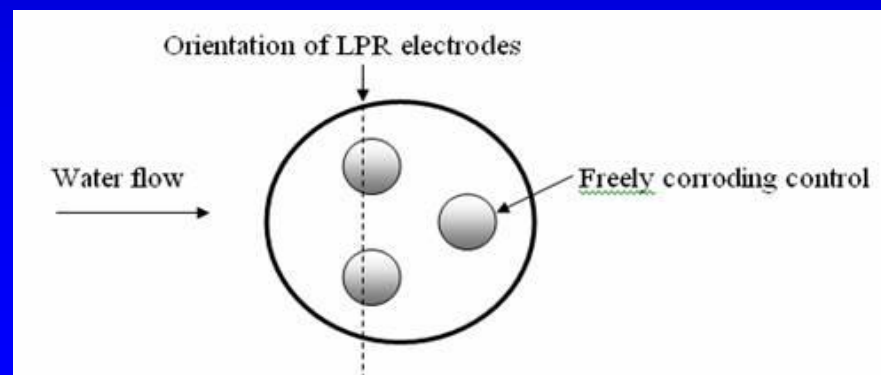


Sensors

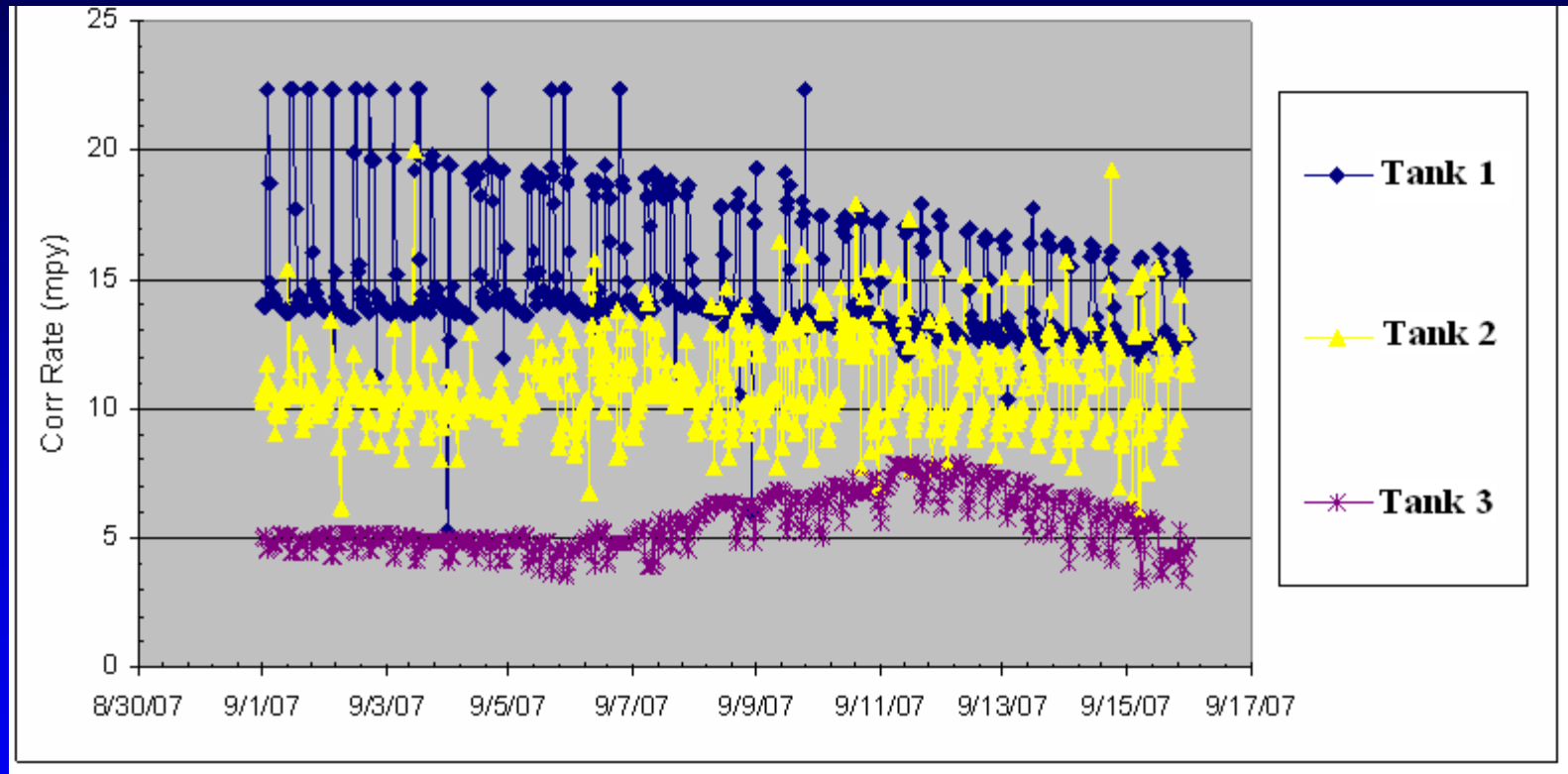


Corrosion Rate Sensor

- Measures linear polarization resistance (LPR) or electrical resistance (ER)
- Calculates instantaneous corrosion rate (LPR)
- Rate can be integrated over time for cumulative metal loss
- “Corrosion imbalance” provides qualitative indication of pitting tendency
- Can be tied in with SCADA systems/ 4-20 mA output



Example corrosion rate data from LPR sensors



A wide variation in general corrosion rates was observed. The lowest rate consistent occurred in one of the water storage tanks at the site. The highest rate occurred at a pressure reducing valve with intermittent flow.



HACH Water Quality Sensor (Pipe Sonde)

- **Multi-parameter sensor that measures**
 - pH
 - Conductivity
 - Turbidity
 - Dissolved oxygen
 - ORP
 - Water pressure & temperature
- **Water and debris-tight for long-term field use**
- **Additional benefits for water security**
- **Can be tied in with SCADA systems/ MODBUS output**



HACH Guardian Blue Water Distribution Monitoring Process

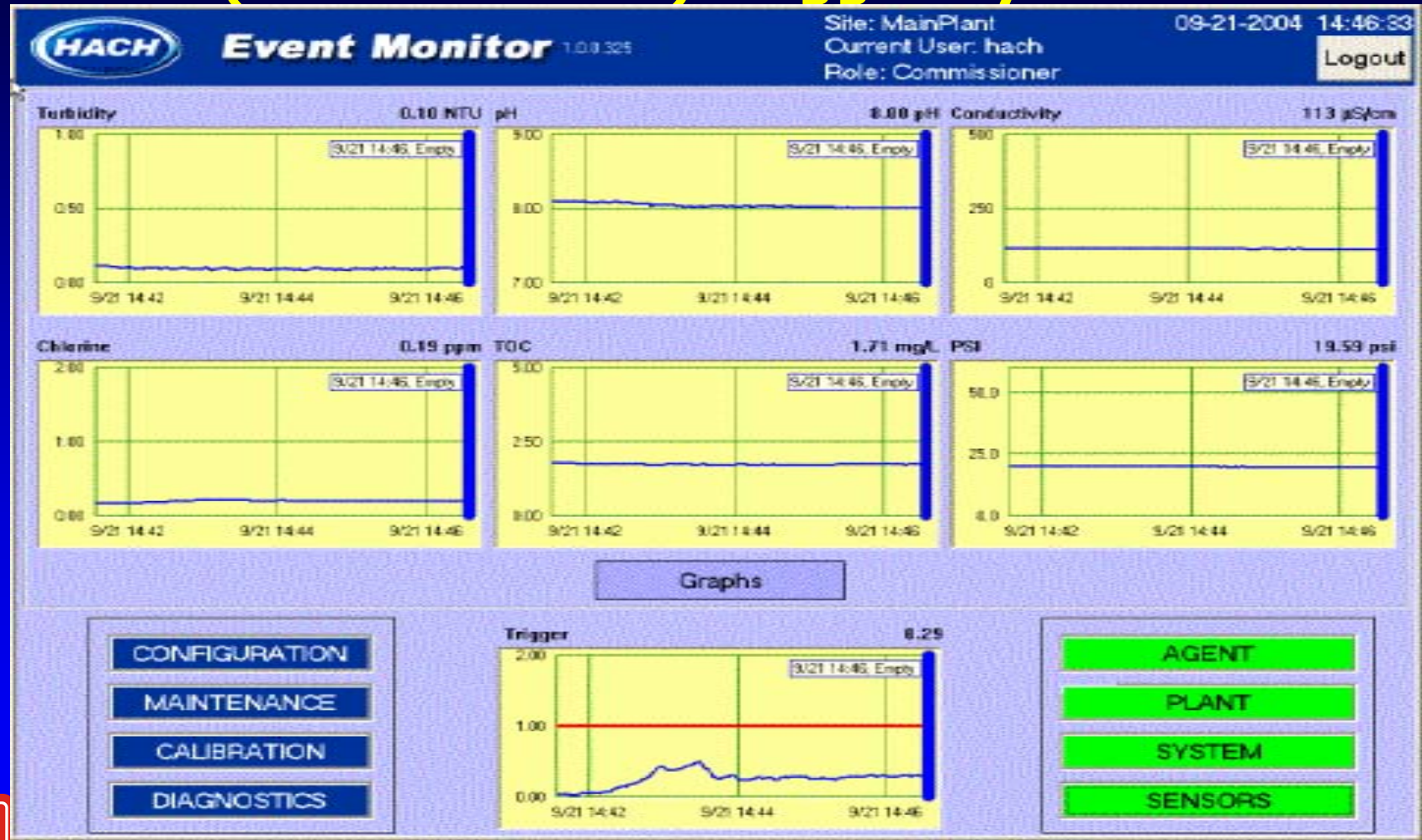


- The System is used to detect and preliminarily classify anomalous events in the drinking water distribution system increasing security and streamlining operations



HACH Water Quality Distribution Monitoring Process

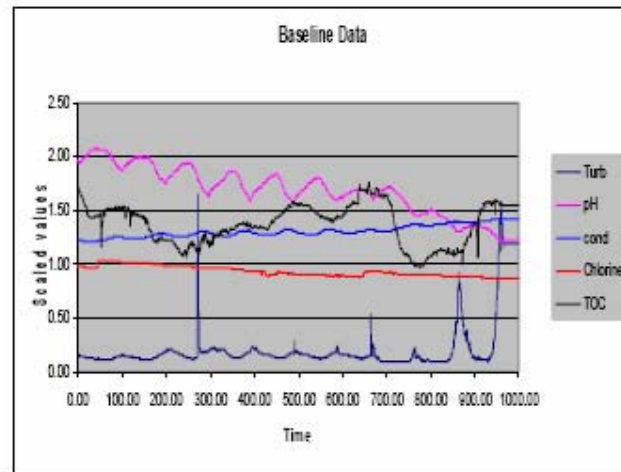
(Event Monitor) Trigger System



- **View all measurements and trigger signal from the main screen.**

HACH Water Quality Distribution Monitoring Process (Event Monitor) Overview

Input Five Parameter Signals

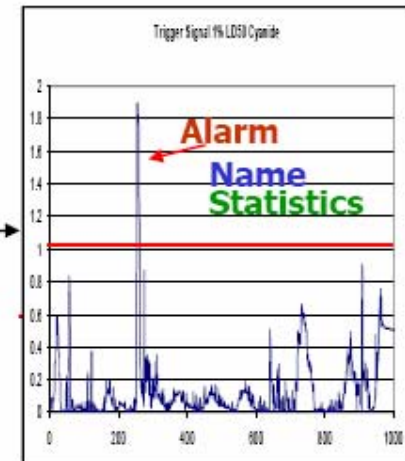


The Event Monitor analyzes plant data, alarms on significant deviations from baseline, reports the Event Name if found, and learns the event fingerprint if not already in the Plant Event Library.

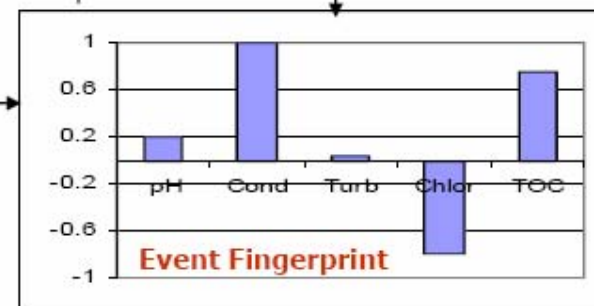
Analyze

Software

Output Single Signal



Learning

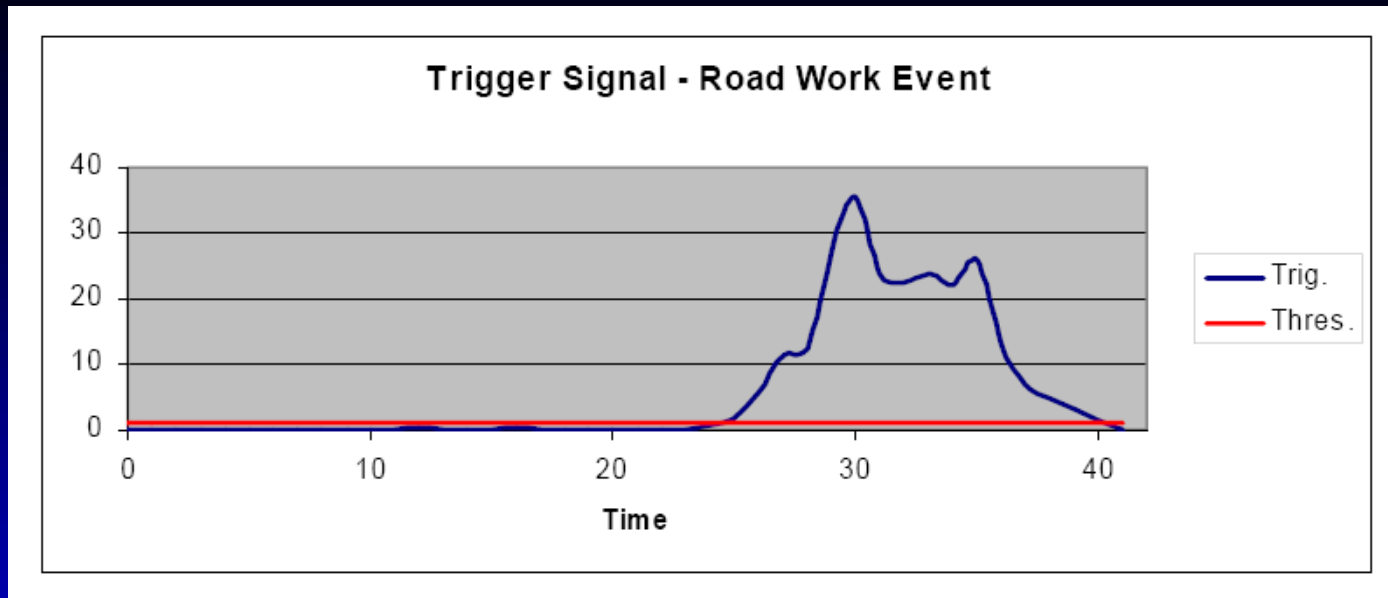


Plant Event Library



36 Inch Main Break





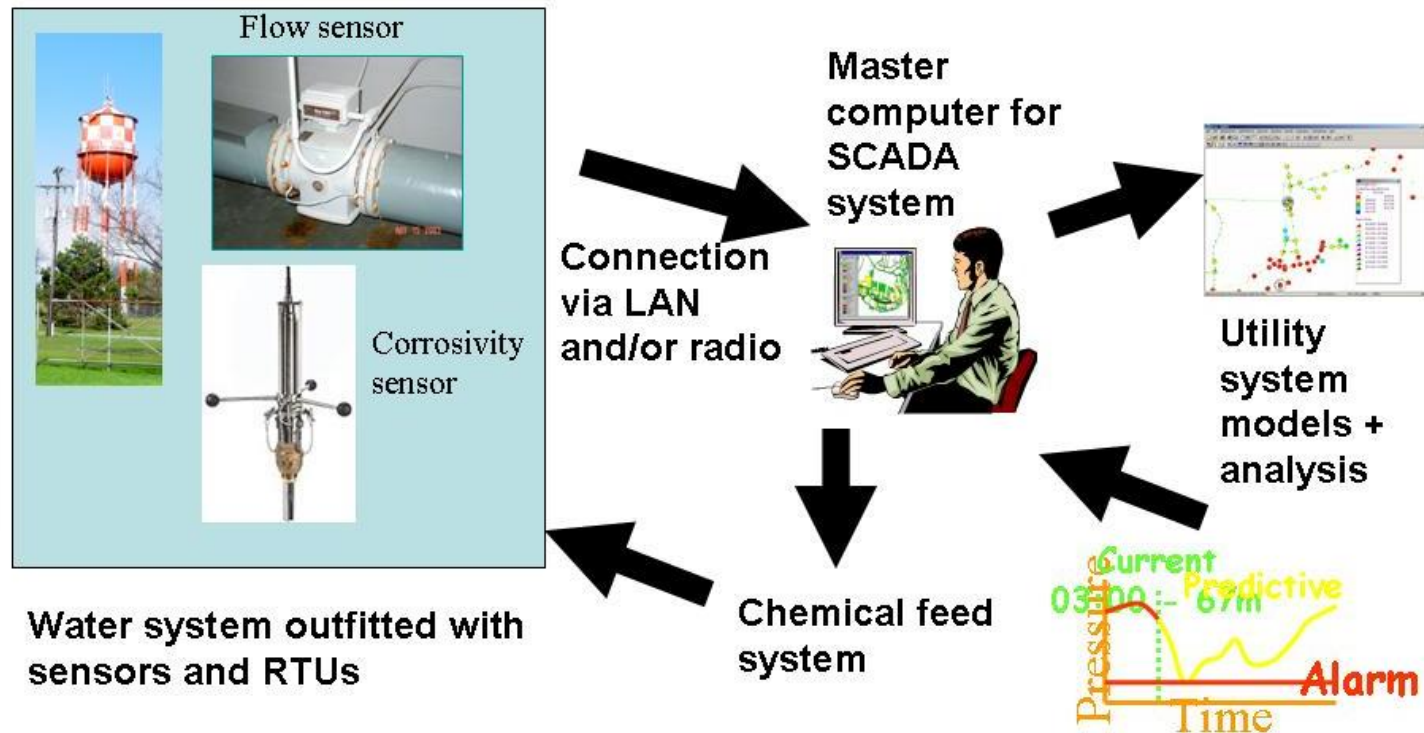
- Road work near a distribution line dislodged biomass and other particulate matter from the lining of the pipe. There was a massive increase in turbidity, which not only showed up on the turbidimeter, but also showed up as an interference in the chlorine measurement (optical). As expected, the conductivity and pH also showed minor changes. The increase in biomass in the water was indicated by the TOC analyzer. This event illustrates the ability of the Event Monitor to detect and alarm on unanticipated events. This event also provides a signature for the materials adhering to the walls of the pipes in this location.



Integration of Sensors and Dynamic Models to Support Water Distribution Networks



Schematic of Corrosion Detection and Management System



RTU = Remote Terminal Unit

SCADA = Supervisory Control and Data Acquisition

LAN = Local Area Network



We Have a Vision: A "Smart" Utility Network

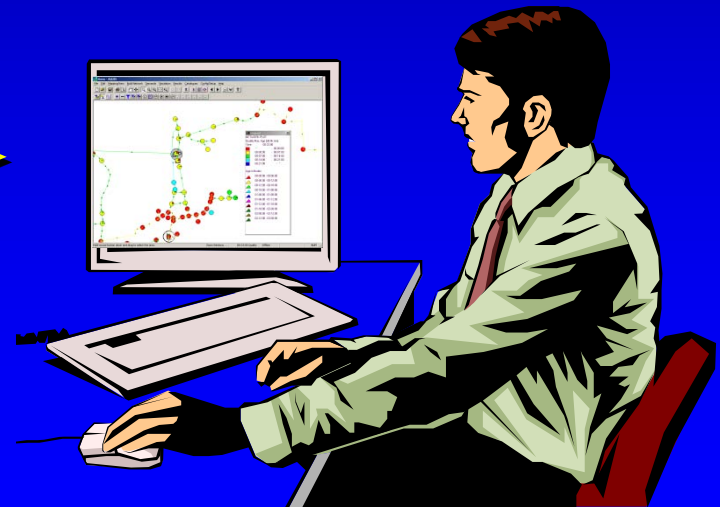
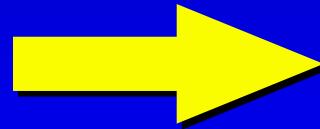
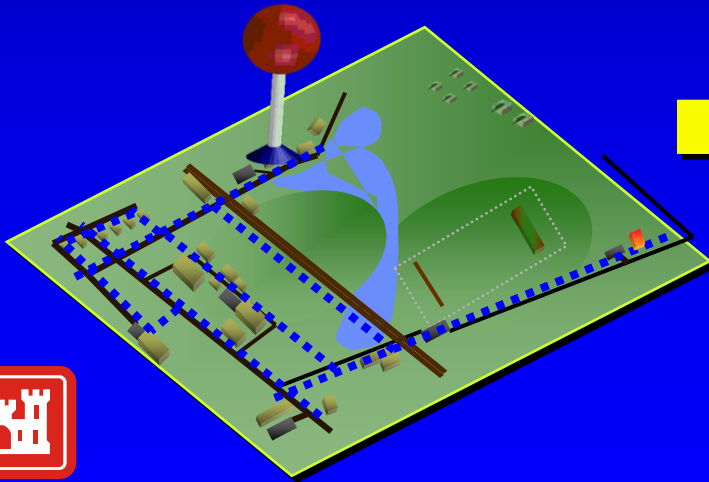
- Notifies the operator when something is wrong.
- Diagnoses the problem
- Solves the problem or recommends corrective action to the operator
- Allows operator to "experiment" with alternative solutions

"There is a problem at the main plant. Turbidity is 12 and chlorine residual is zero. "

"Contamination is suspected"

"Recommendation: Close valves at main plant. Do you want to do that?"

"Do you want to simulate what will happen if we do that? Do you want to try something else?"

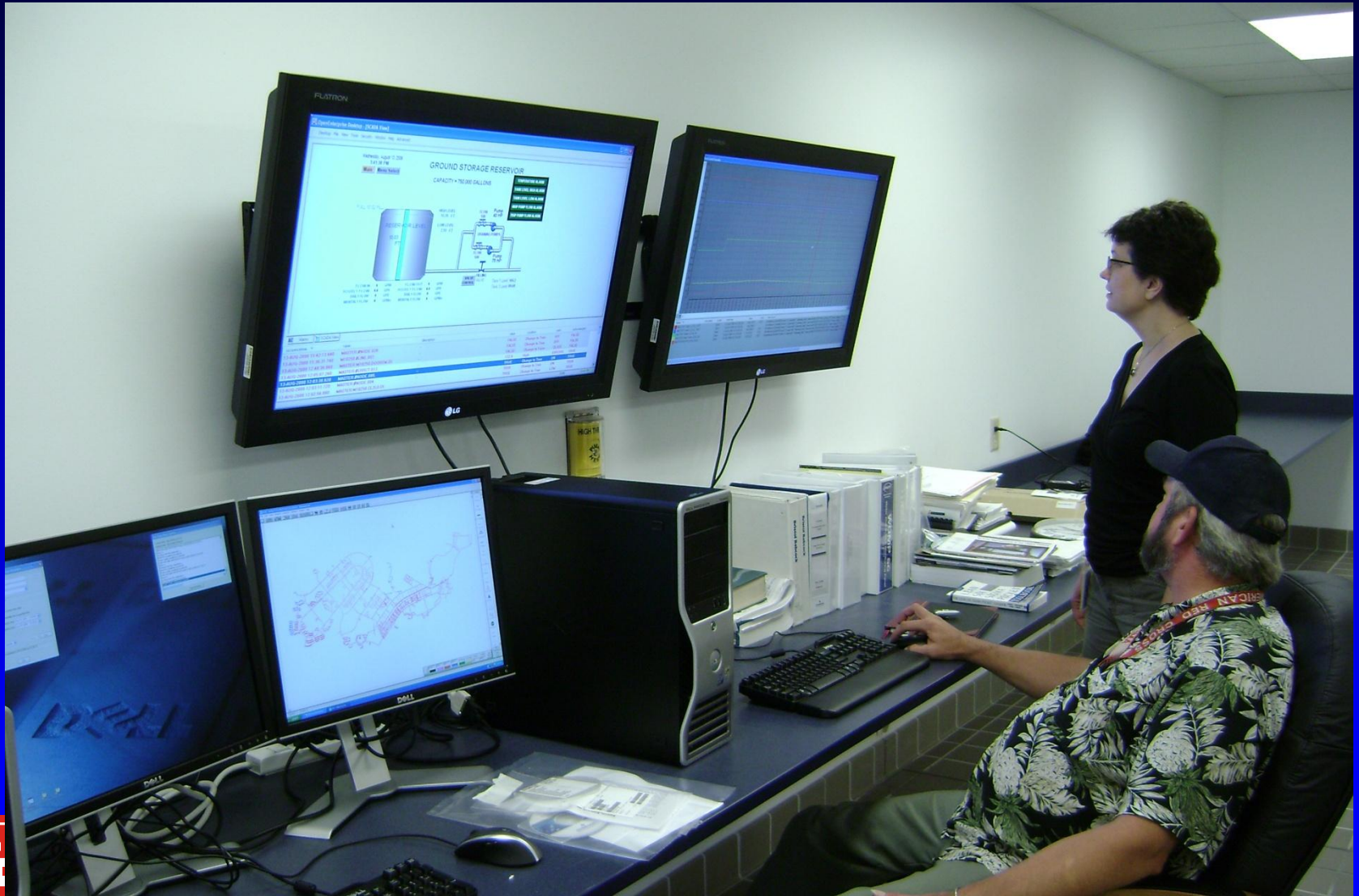


Sensor monitoring via SCADA

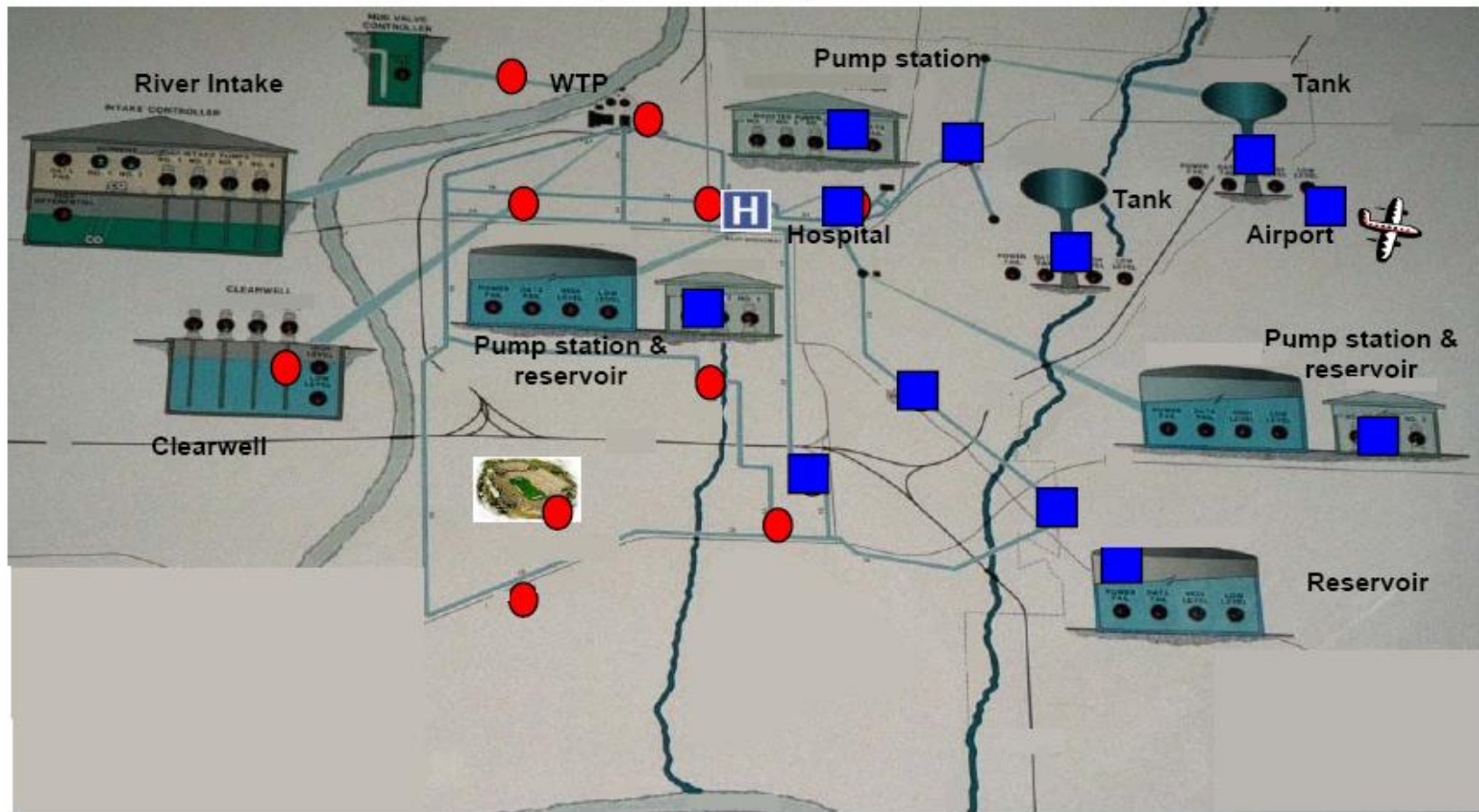
- Utilized army installation's existing Bristol Babcock SCADA system
- Corrosion rate and water quality sensors are monitored
- Data transmitted to Public Works office



Monitoring at an Army Installation



*Best Approach is a Network Approach
Not a choice of just one, or two instruments*



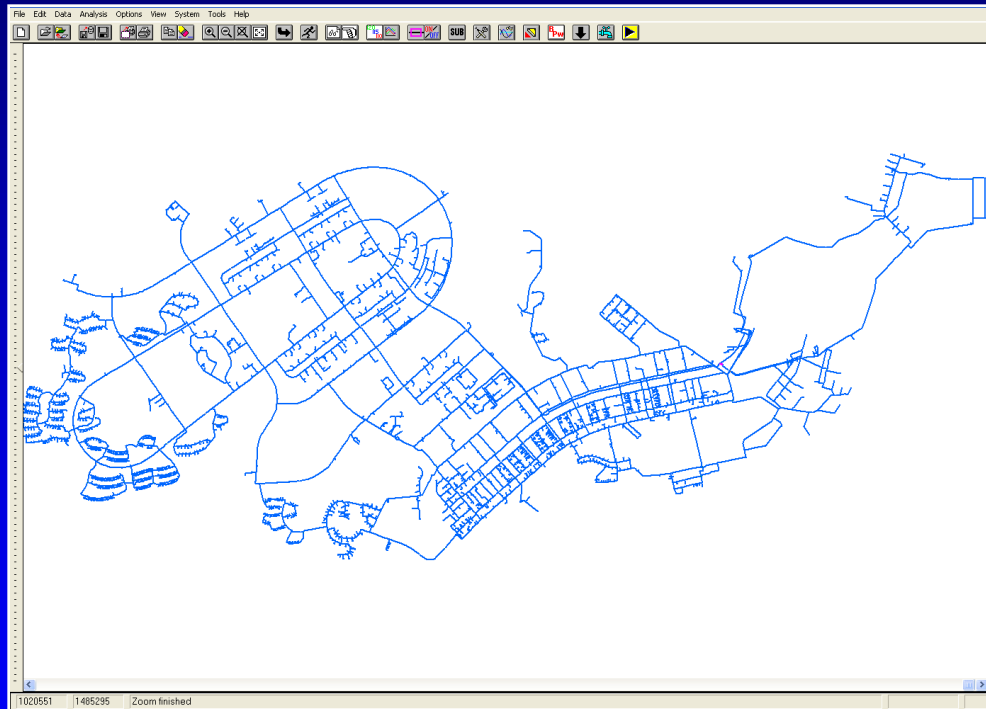
System Overview

Real-Time Model

SCADA
System

Field
Reports

Lab
Data



Hydraulics

- Pressure
- Flow
- Control

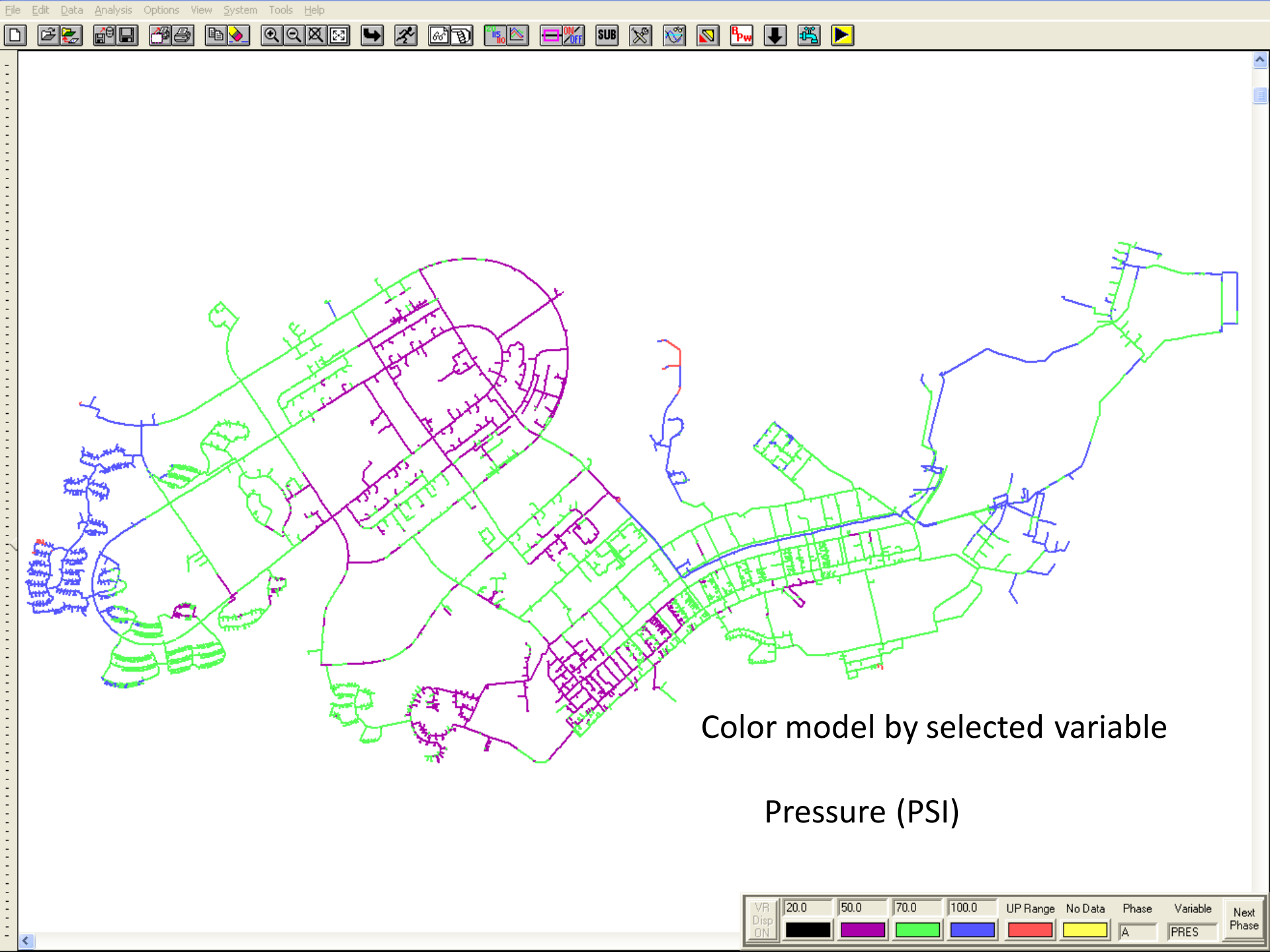
Water Quality

- Measures
- Constituents

Corrosion

- Measures
- Indexes
- History

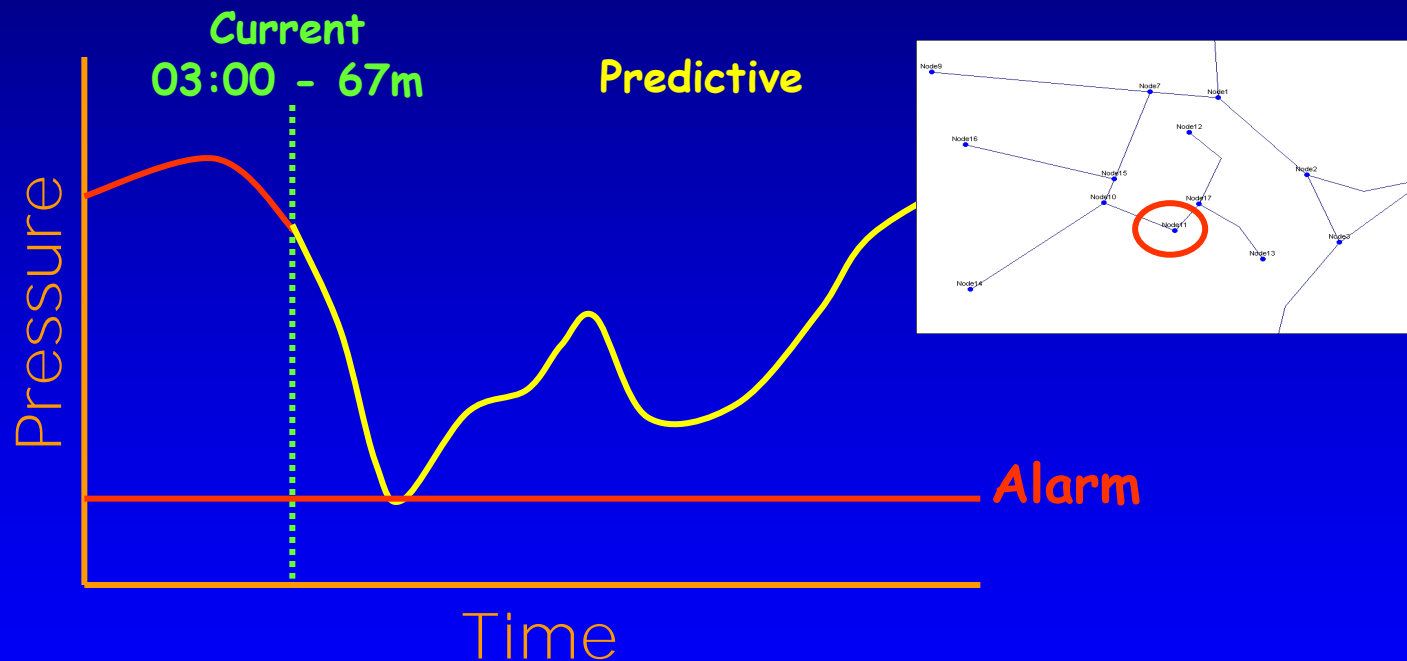




Color model by selected variable

Pressure (PSI)

Simulation combined with analysis algorithms provides proactive identification of problems

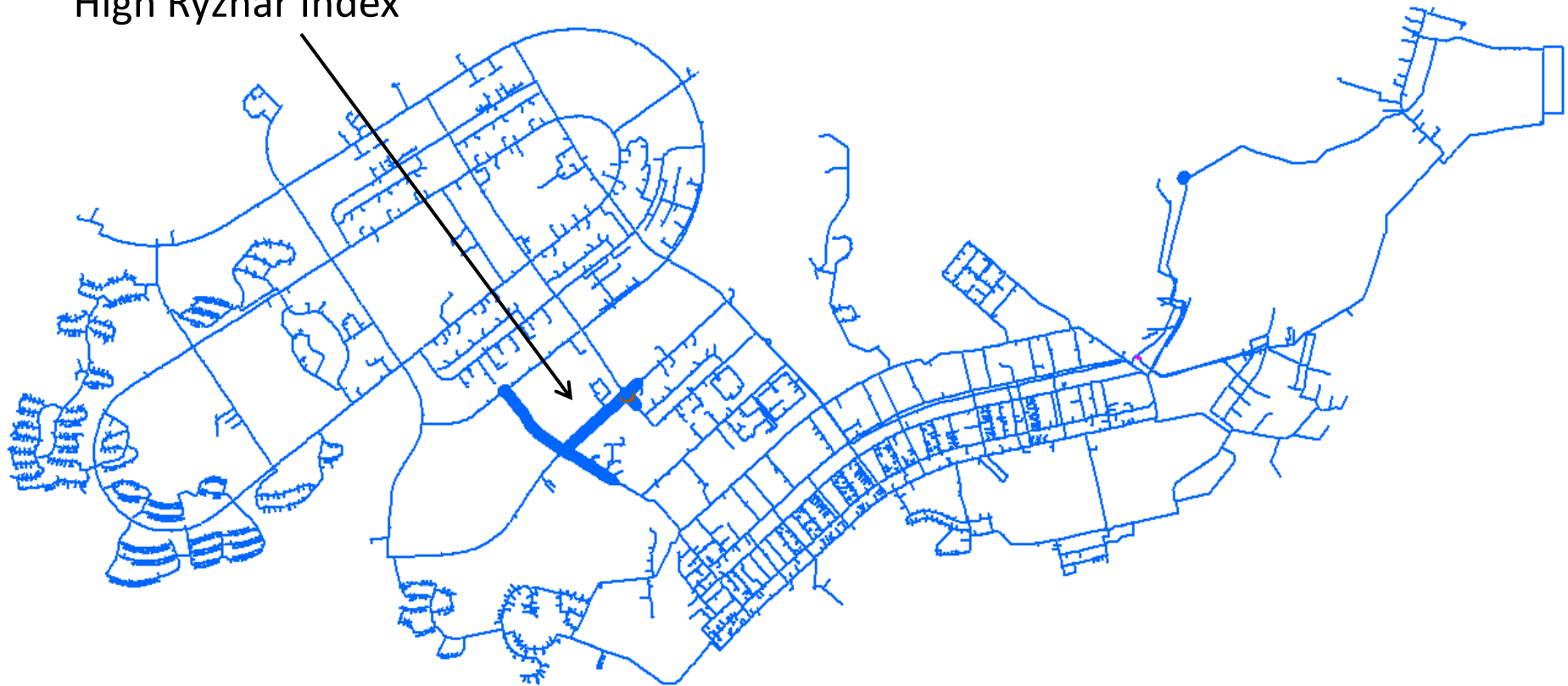


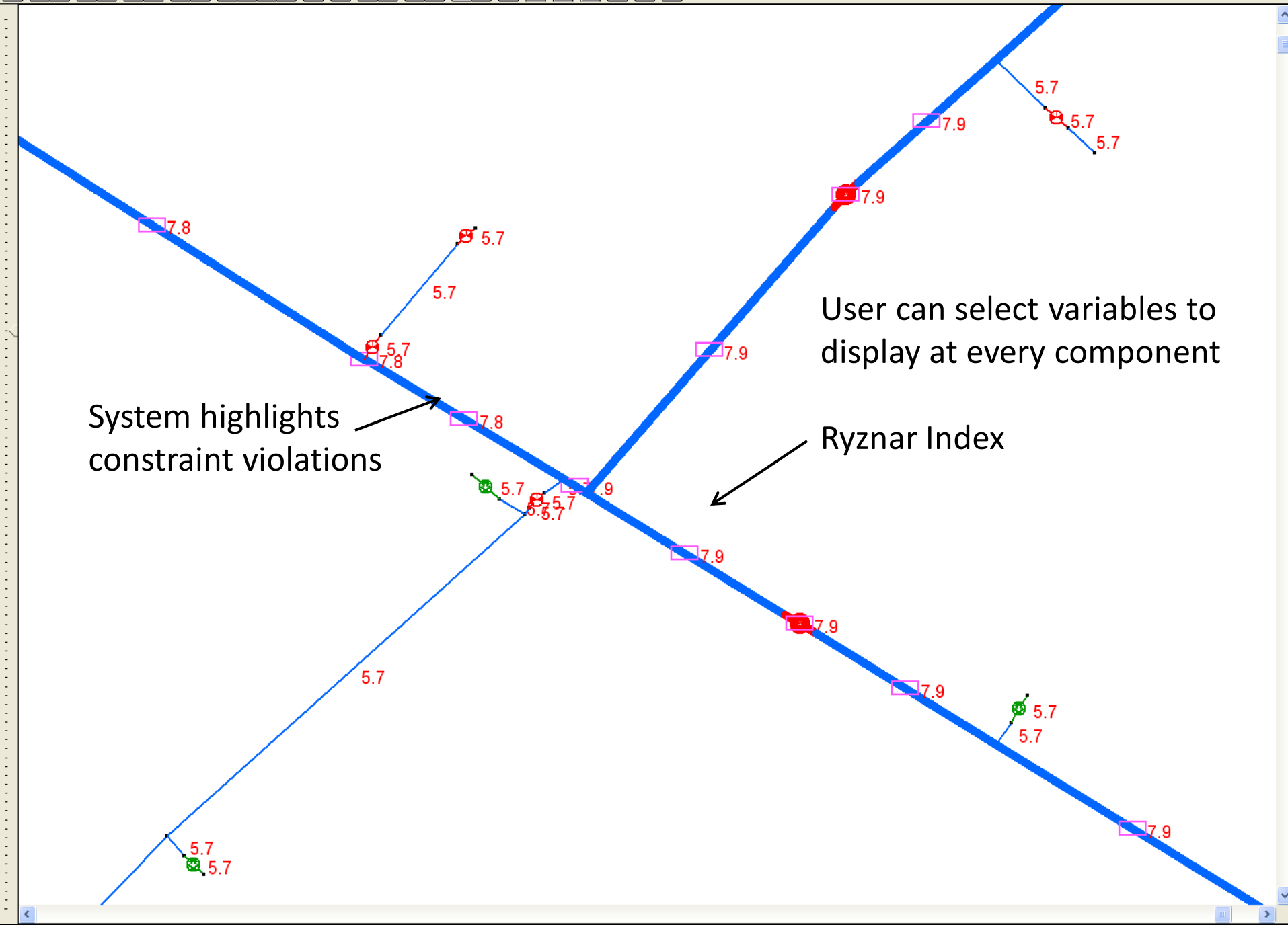
Ultimate “condition assessment” tool



Highlight components with analysis values
that violate constraints

High Ryznar Index





Water System Quality and Corrosion Monitoring and Analysis Benefits

- **Enhance system operation and reduce downtime**
- **Improved customer satisfaction and relations**
- **Satisfy regulatory record keeping and reporting requirements**
- **Reduce labor costs associated with time and travel.**
- **Alert operators and managers to undesirable changes in water quality**
- **Distribution and plant personnel can troubleshoot remotely**
- **Distribution and plant personnel can identify trends and adjust operating parameters more efficiently**



The EPA website lists a number of benefits of remote monitoring in the distribution system.

Summary

This is system that consists of:

- **Corrosion Rate Sensors**
- **Water Quality Sensors (HACH Pipe-Sonde)**
- **Water Distribution Monitoring Process Sensors (HACH Guardian Blue)**

Tying it all together:

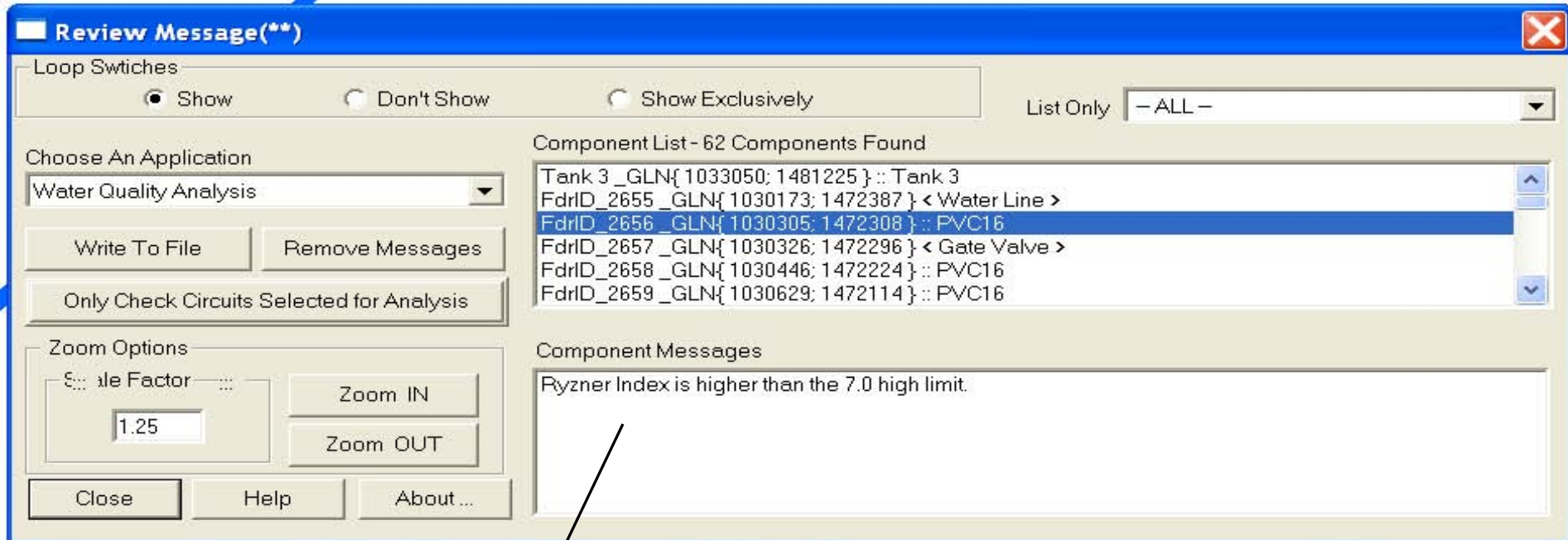
- **Each of these technologies contributes to improved corrosion control and water quality management for water distribution systems**



Project Status

- **All major components modeled from tanks, sources and water treatment plant, pipes and valves down to individual buildings**
 - **Loaded from GIS**
- **Running model using live data feed from SCADA**
 - **ODBC connection between Bristol Babcock Open Enterprise SCADA Server and Distributed Engineering Workstation (Dew) model**
- **Can hand enter lab and field data at components in model**
- **Generating hydraulic, water quality and corrosion data and index information using component installation data and attached measurements**
- **System highlights high and low limit violations**
- **Completed initial installation test and review in December**
- **Running and refining as regular part of water system operations**
 - **December 2008 through June 2009**





Review constraint violations as a list

- Select component from list
- Window pans to selected component

